DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of claims 1-4 in the reply filed on 2/18/2010 is acknowledged.

2. Claims 5-10 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected method of making a solar cell, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 2/18/2010.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim (US 20030037815), Wenham (US 4748130) and Green (US 5081049).

As to claim 1, Kim teaches a photovoltaic cell comprising an electric solid material contact between a semiconductor layer which inherently has a thickness, d_{HL}, and a plurality of metal emitters (19a) which inherently have a space charge zone extent w within the semiconductor layer. Kim teaches that that the emitters are embedded in an oxide layer applied on the semiconductor layer ([0006]) and a transparent conductive oxide layer electrically insulated from the semiconductor layer by the oxide layer (14, [0052]). The emitters are characterized in a rib-like manner (figure 1). The Examiner notes that minority carriers will inherently migrate to the space charge zone over a length L.

Kim is silent to the emitters being nano sized, the emitters being separated by a distance $D \leq 1.41L$ and the depth of the emitters into the semiconductor being $T \geq d_{HL} - 0.5L + w$.

Wenham teaches that it is known in the solar arts that the use of buried contacts minimizes losses due to shadowing. Wenham teaches that groove/emitter depth can compensate for loss in width to give the same cross sectional area with only a fraction of the shading loss. Furthermore, Wenham teaches that the depth and width can are flexible and that increasing depth reduces the series resistance of the contact without altering shading loss (col. 1, line 55 to col. 2, line 13). It would have been obvious to one of ordinary skill in the art at the time of the invention to optimize the width to nanometer size and optimize the depth because reducing the width reduces shadowing effects and increasing the depth reduces series resistance, as taught by Wenham (col. 1, line 55 to col. 2, line 13).

Green teaches spacing grooves of a buried contact solar cell at (1.25 to 1.5)L (col. 5, lines 15-20). In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists (MPEP 2144). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the spacing of Green in Kim because appropriate sizing of such structures to the diffusion length results in extremely high collection probabilities, as taught by Green (col. 5, lines 3-6).

Regarding claim 2, modified Kim teaches that the emitters have lateral branches in the semiconductor layer (Green: figure 6).

Regarding claim 3, modified Kim teaches that a reflective surface is applied to the rear surface of the semiconductor layer in front of the rear contact (Kim: [0030]).

Regarding claim 4, modified Kim teaches that an antireflection coating is applied to the transparent conductive oxide (Kim: [0007] and [0029]).

6. Claims 1-2 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakato (*solar cells based on a new junction 'transparent conductor/thin insulator having ultrafine metal islands/semiconductor'*), Wenham and Green.

As to claim 1, Nakato teaches a photovoltaic cell comprising an electric solid material contact between a semiconductor layer which inherently has a thickness, d_{HL}, and a plurality of metal nano emitters (metal islands: page 940, ¶ 1) which inherently have a space charge zone extent w within the semiconductor layer. Nakato teaches that that the emitters are embedded in an oxide layer applied on the semiconductor layer (insulator) and a transparent conductive oxide layer electrically insulated from the

semiconductor layer by the oxide layer (figure 2). The emitters are characterized in a rib-like manner (figure 2). The Examiner notes that minority carriers will inherently migrate to the space charge zone over a length L.

Nakato is silent to the emitters specifically being separated by a distance $D \leq 1.41L$ and the depth of the emitters into the semiconductor being $T \geq d_{HL} - 0.5L + w$.

Wenham teaches that it is known in the solar arts that the use of buried contacts minimizes losses due to shadowing. Wenham teaches that groove/emitter depth can compensate for loss in width to give the same cross sectional area with only a fraction of the shading loss. Furthermore, Wenham teaches that the depth and width can are flexible and that increasing depth reduces the series resistance of the contact without altering shading loss (col. 1, line 55 to col. 2, line 13). It would have been obvious to one of ordinary skill in the art at the time of the invention to optimize the width to nanometer size and optimize the depth because reducing the width reduces shadowing effects and increasing the depth reduces series resistance, as taught by Wenham (col. 1, line 55 to col. 2, line 13) especially in light of the fact that Nakato acknowledges that should the nano-emitters become too small or too sparesely distributed, the current densities become very high causing a decrease in efficiency (page 940, ¶ 3 to page 941, ¶ 1).

Green teaches spacing grooves of a buried contact solar cell at (1.25 to 1.5)L (col. 5, lines 15-20). In the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists (MPEP 2144). It would have been obvious to one of ordinary skill in the art at the time of the invention to

use the spacing of Green in Nakato because appropriate sizing of such structures to the diffusion length results in extremely high collection probabilities, as taught by Green (col. 5, lines 3-6).

Regarding claim 2, modified Nakato teaches that the emitters have lateral branches in the semiconductor layer (Green: figure 6).

Regarding claim 4, modified Nakato teaches the use of an antireflection coating (Wenham: col. 4, lines 33 and 48). It would have been obvious to use an antireflection coating to maximize radiation absorption by minimizing reflection at the light incident surface.

7. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakato (*solar cells based on a new junction 'transparent conductor/thin insulator having ultrafine metal islands/semiconductor'*), Wenham and Green as applied to claim 1 above and further in view of Kim.

Regarding claim 3, modified Nakato is silent to a reflective surface applied to the rear surface of the semiconductor layer in front of the rear contact. Kim teaches that a reflective surface is applied to the rear surface of the semiconductor layer in front of the rear contact (Kim: [0030]). It would have been obvious to include a reflective surface at the non-incident side of the solar cell to promote reflection of unabsorbed light back into the cell again maximizing radiation absorption.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **MIRIAM BERDICHEVSKY** whose telephone number is (571)270-5256. The examiner can normally be reached on M-Th, 10am-8pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Alexa Neckel can be reached on (571) 272-1446. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/M. B./
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